

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

Claims 1 to 4. (canceled)

Claim 5. (currently amended) ~~[[The]]~~ A method of manufacturing a steel product ~~according to claim [[4]]~~ comprising heat treating a steel product which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line, wherein [[the]] a number of times of passage of the steel product through the induction heating apparatuses is such [[a]] number of times that a heat treatment time determined from the relationship between , in which a surface treatment of the steel product and a thickness-wise center temperature of the steel product are determined from the number of times of passage, [[the]] a transfer speed of the steel product[[,]] and [[the]] an amount of electric power for the

induction heating apparatuses, ~~which is found using the dimensions and the necessary temperature rise of the steel product fall within a predetermined range, is becomes~~ the shortest,

and wherein an optimum number of times of passage in which the number of times of passage becomes the shortest is determined by the following steps:

(a) determining the dimensions of the steel product and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is one,

(c) determining the transfer speed and the electric power for the induction heating apparatuses when the number of times of passage is not less than two,

(d) selecting the optimum number of times of passage in which the heat treatment time becomes the shortest, and determining the transfer speed and the amount of electric power for the induction heating apparatuses for each of the selected optimal number of times of passage.

Claim 6. (currently amended) The method of manufacturing a steel product according to claim [[4]] 5, wherein ~~in the case where~~ when the heat ~~treatment~~ treating is carried out ~~with~~ when the number of times of passage ~~being~~ is three or more, a transfer speed of the steel product is changed every time of passage through the induction heating apparatuses.

Claim 7. (currently amended) The method of manufacturing a steel product according to claim [[4]] 5, wherein ~~in the case where~~ when the heat ~~treatment~~ treating is carried out with the number of times of passage being n which is equal to or more than three, transfer speeds of the steel product at a nth passage and at a (n-1)th passage are larger than those at a (n-2)th passage or before.

Claim 8. (currently amended) A method of manufacturing a steel product [[,]] comprising ~~the step of~~ heat treating a steel product ~~having~~ which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of

induction heating apparatuses, which are installed on the hot rolling line[[,]] ~~at least once, and~~

wherein ~~[[the]]~~ a number of times of passage of the steel product through the induction heating apparatus is such [[a] number of times that a heat treatment time, in which a surface temperature and a thickness-wise center temperature of the steel product are determined based on the number of times of passage, a transfer speed of the steel product and an amount of electric power for the induction heating apparatuses fall [[in]] within a predetermined temperature range within a target treatment time,
and wherein an optimum number of times of passage is within the target treatment time and is determined by the following steps:

(a) determining the dimensions and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is one,

(c) determining the transfer of speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is not less than two,

(d) selecting the optimum number of times of passage, in which the heat treatment time becomes the target treatment time, and determining the transfer speed and the amount of electric power for the induction heating apparatus for each of the selected optimum number of times of passage.

Claim 9. (currently amended) The method of manufacturing a steel product according to claim 8, wherein [[a]] the target treatment time is set to [[the]] a time[[,]] which prevents a succeeding steel product from waiting in processes prior to the heat ~~treatment process~~ treating, or [[the]] a time making which results in a waiting time of [[the]] a succeeding steel product being the shortest when ~~passed~~ the target treatment time has passed.

Claim 10. (currently amended) The method of manufacturing a steel product according to claim 9, wherein [[a]] the target treatment time is calculated on the basis of [[the]] a time[[,]] at which cooling of a succeeding steel product is completed, or on the basis of the time[[,]] at which the succeeding steel product arrives at the induction heating apparatuses.

Claim 11. (currently amended) The method of manufacturing a steel product according to claim 9, wherein the number of times of passage through the induction heating apparatuses is a number ~~making~~ which results in a minimum electric power consumption ~~minimum~~, among such numbers of times ~~[[that]]~~ the heat treatment time ~~determined from the relationship between number of times of passage~~ ~~[[,]] the transfer speed of the steel product~~ ~~[[,]] and the electric power for the induction heating apparatuses~~ ~~[[,]] which relationship is found using the dimensions and the necessary temperature rise of the steel product~~ ~~[[,]]~~ falls within ~~[[a]]~~ the target treatment time.

Claim 12. (currently amended) A method of manufacturing a steel product ~~[[,]]~~ comprising ~~the step of~~ heat treating a steel product ~~having~~ which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line ~~[[,]] at least once~~, and

~~wherein the steel product is subjected to heat treatment so that heat treatment time~~ ~~[[,]] which is calculated on the basis of~~

~~the dimensions and the necessary temperature rise of the steel product[[,]]the number of times of passage through the induction heating apparatuses[[,]]and heating capacities of the induction heating apparatuses[[,]]and which elapses until surface temperature of the steel product does not exceed a predetermined upper limit temperature and temperature in a predetermined position inside the steel product reaches a target temperature[[,]]falls within a target treatment time~~

a surface temperature of the steel product and a temperature in a predetermined position inside the steel product are each determined as a variable based on the number of times of passage, a transfer speed of the steel product and an amount of electric power for the induction heating apparatuses,

wherein the steel product is subjected to the heat treating so that a heat treatment time, until the surface temperature of the steel product does not exceed a predetermined upper limit temperature and the temperature is a predetermined position inside the steel product reaches a target temperature, falls within a target treatment time,

and wherein the heat treatment conditions in which the heat treatment time is within the target treatment time is determined by the following steps:

(a) determining the dimensions of the steel product and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatus when the number of times of passage is one,

(c) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is not less than two,

(d) selecting an optimum number of times of passage, in which the heat treatment time becomes the target treatment time, and determining the transfer speed and the amount of electric power for the induction heating apparatuses for each of the selected optimum number of times of passage.

Claim 13. (currently amended) The method of manufacturing a steel product according to claim 12, wherein ~~[[a]]~~ the target treatment time is set to ~~[[the]]~~ a time~~[[,]]~~ which prevents a

succeeding steel product from waiting in processes prior to the heat ~~treatment process treating~~, or ~~[[the]]~~ a time ~~making which~~ results in a waiting time of ~~[[the]]~~ a succeeding steel product being the shortest when ~~passed~~ the target treatment time has passed.

Claim 14. (currently amended) The method of manufacturing a steel product according to claim 13, wherein heating of ~~[[a]]~~ the steel product is completed within ~~[[a]]~~ the target treatment time and performed so that power consumption is ~~made~~ at a minimum.

Claim 15. (currently amended) The method of manufacturing a steel product according to claim 13, wherein ~~in the case where~~ when the heat ~~treatment~~ treating is carried out ~~with~~ when the number of times of passage ~~being~~ is three or more, and a transfer speed of the steel product at ~~[[the]]~~ a last time of passage is larger than that at ~~[[the]]~~ a first time of passage.

Claim 16. (currently amended) A method of manufacturing a steel product~~[[,]]~~ comprising ~~the step of~~ heat treating a steel product ~~having~~ which has been subjected to quenching or

accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line[[,]] ~~at least once, and~~

~~wherein the steel product is subjected to heat treatment so that heat treatment time[[,]] which is calculated on the basis of the dimensions and the necessary temperature rise of the steel product[[,]] the number of times of passage through the induction heating apparatus[[,]] and heating capacities of the induction heating apparatus[[,]] and which elapses until surface temperature of the steel product does not exceed a predetermined upper limit temperature and temperature in a predetermined position inside the steel product reaches a target temperature[[,]] becomes the shortest~~

a surface temperature of the steel product and a temperature in a predetermined position inside the steel product are each determined as a variable based on the number of times of passage, a transfer speed of the steel product and an amount of electric power of the induction heating apparatuses,

wherein the steel product is subjected to the heat treating so that a heat treatment time, until the surface temperature of the steel product does not exceed a predetermined upper limit temperature and the temperature in a predetermined position inside the steel product reaches a target temperature, becomes the shortest,

and wherein an optimum number of times of passage on which the number of times of passage becomes the shortest is determined by the following steps:

(a) determining the dimension of the steel product and a necessary temperature rise of the steel product to be subjected to heat treating,

(b) determining the transfer speed and the amount of electric power when the number of times of passage is one,

(c) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is less than two,

(d) selecting the number of times of passage, in which the heat treatment time becomes the shortest, and determining the transfer speed and the amount of electric power for the induction heating

apparatuses for each of the selected optimum number of times of passage.

Claim 17. (currently amended) The method of manufacturing a steel product according to claim 16, wherein ~~in the case where~~ when the heat treatment treating is carried out ~~with~~ when the number of times of passage ~~being~~ is three or more, ~~[[a]] and the~~ transfer speed of the steel product at ~~[[the]]~~ a last time of passage is larger than that at ~~[[the]]~~ a first time of passage.

Claim 18. (currently amended) A method of manufacturing a steel product~~[[,]]~~ comprising ~~the step of~~ heat treating a steel product ~~having~~ which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product three or more times through two to five induction heating apparatuses, which are installed on the hot rolling line~~[[,]]~~ ~~three times or more.~~

Claim 19. (currently amended) The method of manufacturing a steel product according to claim 18, wherein the heat ~~treatment~~

treating is carried out with the number of times of passage, which prevents a succeeding steel product from waiting in processes prior to the heat ~~treatment process~~ treating, or which ~~makes results in~~ a waiting time of ~~[[the]]~~ a succeeding steel product being the shortest ~~in the case where~~ when the succeeding steel material waits in the preceding process.

Claim 20. (currently amended) The method of manufacturing a steel product according to claim 19, wherein ~~in the case where~~ when the heat ~~treatment~~ treating is carried out ~~with~~ when the number of times of passage ~~being~~ is three or more, and a transfer speed of the steel product at ~~[[the]]~~ a last time of passage is larger than that at ~~[[the]]~~ a first time of passage.

Claim 21. (canceled)

Claim 22. (new) The method of manufacturing a steel product according to claim 5, wherein the method for determining the transfer speed of the steel product and the amount of electric power for the induction heating apparatuses at each of the number

of times of passage in the steps (b) and (c) comprises solving an optimization problem at every time of passage, in which the variables include the transfer speed of the steel product and the amount of the electric power for each induction heating apparatus, constraint conditions include the surface temperature of the steel product and the center temperature of the steel product are within a predetermined range of temperatures, and an objective function includes the heat treatment time and/or the amount of consumed electricity.

Claim 23. (new) The method of manufacturing a steel product according to claim 22, wherein the optimization problem in the steps (b) and (c) is solved beforehand and wherein at least one of the transfer speed at every time of passage according to the dimensions of the steel product is stored in a table and the amount of electric power of each induction heating apparatus is stored in a table.

Claim 24. (new) The method of manufacturing a steel product according to claim 8, wherein the method for determining the

transfer speed of the steel product and the amount of electric power for the induction heating apparatuses at each of the number of times of passage in the steps (b) and (c) comprise solving an optimization problem at every time of passage in which variables include the transfer speed of the steel product and the amount of electric power for each induction heating apparatus, constraint conditions include the surface temperature of the steel product and the center temperature of the steel product are within a predetermined range of temperatures, and an objective function includes the heat treatment time and/or the amount of consumed electricity.

Claim 25. (new) The method of manufacturing a steel product according to claim 24, wherein the optimization problem in the steps (b) and (c) is solved beforehand and wherein at least one of the transfer speed at every time of passage according to the dimensions of the steel product is stored in a table and the amount of electric power of each induction heating apparatus is stored in a table.

Claim 26. (new) The method of manufacturing a steel product according to claim 12, wherein the method for determining the transfer speed of the steel product and the amount of electric power for the induction heating apparatuses at each of the number of times of passage in the steps (b) and (c) comprise solving an optimization problem at every time of passage in which variables include the transfer speed of the steel product and the amount of the electric power for each induction heating apparatus, constraint conditions include the surface temperature of the steel product and the center temperature of the steel product are within a predetermined range of temperatures, and an objective function includes the heat treatment time and/or the amount of consumed electricity.

Claim 27. (new) The method of manufacturing a steel product according to claim 26, wherein the optimization problem in the steps (b) and (c) is solved beforehand and wherein at least one of the transfer speed at every time of passage according to the dimensions of the steel product is stored in a table and the

amount of electric power of each induction heating apparatus is stored in a table.

Claim 28. (new) The method of manufacturing a steel product according to claim 16, wherein the method for determining the transfer speed of the steel product and the amount of electric power for the induction heating apparatuses at each of the number of times of passage in the steps (b) and (c) comprise solving an optimization problem at every time of passage in which variables include the transfer speed of the steel product and the amount of the electric power for each induction heating apparatus, constraint conditions include the surface temperature of the steel product and the center temperature of the steel product being within a predetermined range of temperatures, and an objective function includes the heat treatment time and/or the amount of consumed electricity.

Claim 29. (new) The method of manufacturing a steel product according to claim 28, wherein the optimization problem in the steps (b) and (c) is solved beforehand and wherein at least one

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of the transfer speed at every time of passage according to the dimensions of the steel product is stored in a table and the amount of electric power of each induction heating apparatus is stored in a table.